New high-temperature superconductor $Bi_1Ca_1Sr_{0.7}Al_{0.5}Cu_4O_y$

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Phases with superconducting transition temperatures of 104 K and 75 K were detected in the ceramic compound $Bi_1Ca_1Sr_{0.7}Al_{0.5}Cu_4O_y$. The results of measurements of the temperature dependence of the resistivity and magnetization of the samples are presented.

The discovery of high-temperature superconductivity[1] initiated an extensive search for new high-temperature superconducting compounds. In all high-temperature superconductors known to date the crystal lattice is comprised of rare-earth elements. We have synthesized a superconducting ceramic compound which does not contain a rare-earth element.

Standard ceramic technology was used to synthesize the compound, whose initial components were oxides and carbonates of the appropriate elements used in proportions corresponding to the compound $Bi_1Ca_1Sr_{0.7}Al_{0.5}Cu_4O_y$. The fabricated samples are black in color and a cut section has a metallic luster.

The components of the initial mixture were identified for monitoring by x-ray methods. The powder diagram of a fine crystalline sample was obtained with a monochromatized CuKα radiation in a DRON-2 diffractometer. The spectrum in Fig. 1 does not have any initial components aside from CuO. The initial part of the spectrum ($2\Theta \approx 6°$) has two strong lines corresponding to the interplanar distances $d_1 = 15.36$ Å and $d_2 = 14.32$ Å. The relatively large interplanar distances and the probable low symmetry of the crystals make the interpretation of the spectra more difficult at this stage.

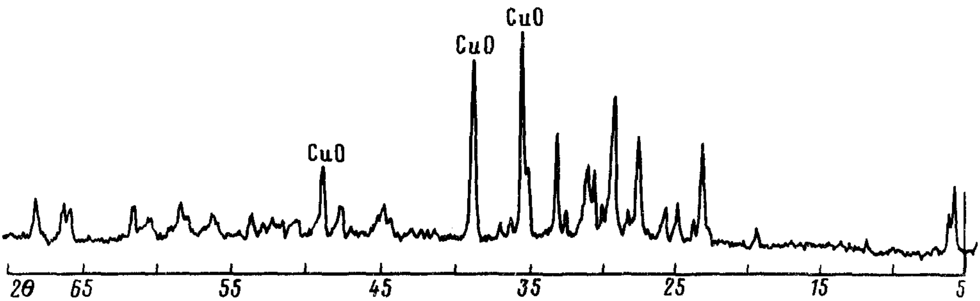

FIG. 1. Diagram of $Bi_1Ca_1Sr_{0.7}Al_{0.5}Cu_4O_y$.

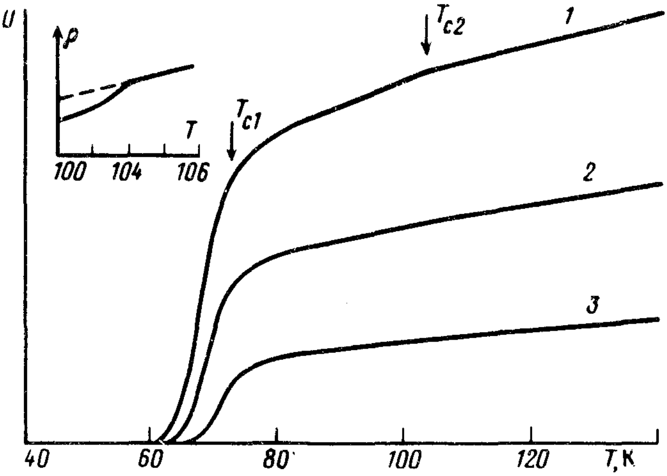

FIG. 2. Temperature dependence of the decrease in the voltage across the sample for the following measuring currents: 1—14 mA; 2—8.5 mA; 3—4.2 mA.

The resistivity of the samples was measured by the four-point method. At room temperature the resistivity is $\rho \approx 2.4 \times 10^{-3}$ $\Omega \cdot$cm. Figure 2 shows the temperature dependence of the voltage across the sample at various measuring currents (I). At $T \gtrsim 110$ K the $\rho(T)$ curve has a metallic nature. In the temperature interval 60–75 K we see a transition to the superconducting state. The temperature at which the super-

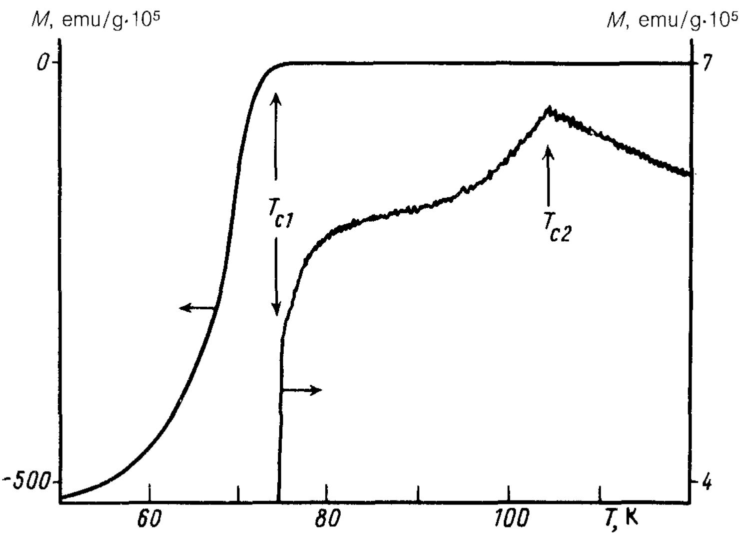

FIG. 3. Temperature dependence of the magnetic moment of the sample in a 3-Oe field.

conducting transition begins, T_{c1}, depends only slightly on the measuring current. This temperature is ≈ 75 K. The temperature at which the instrumental zero is reached decreases with increasing I. At low measuring currents the transition width is $\Delta T \approx 8$–10 K. At 104 K, the $\rho(T)$ curve exhibits an anomaly which is shown in the inset in Fig. 2 on an enlarged scale. We assume that the sample has a phase whose superconducting transition temperature is 104 K.

The presence of two phases with $T_{c1} \approx 75$ K and $T_{c2} \approx 104$ K was confirmed by the results of magnetic measurements (Fig. 3). The magnetic moment was measured in an external field $H = 3$ Oe. At $T < 75$ K the sample reveals a clearly defined diamagnetic behavior characteristic of superconductors. At these temperatures the hysteresis loop is typical of high-temperature superconductors. A convincing evidence of the presence of a phase with $T_{c2} \approx 104$ K is the diamagnetic component of the $M(T)$ curve at temperatures from 75 K to 104 K. The relative volume of this phase, estimated from the magnetic measurements, does not exceed a few percent. This phase manifests itself clearly, nevertheless, on the $M(T)$ curve and on the $\rho(T)$ curve. At $T > 104$ K the sample is slightly paramagnetic, a situation which is probably due to the presence of the CuO phase.

The results presented above thus allow us to conclude that the new compound $Bi_1Ca_1Sr_{0.7}Al_{0.5}Cu_4O_y$ has phases with superconducting transition temperatures of 104 K and 75 K.

[1]J. G. Bednorz and K. A. Müller, Z. Phys. **B64**, 189 (1986).

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